

Amendments to the Specification:

Please delete the three paragraphs starting on Page 3, line 25 and ending on Page 4, line – and insert the following:

Referring to FIG. 1 of the drawings, a digital communication network 10 includes a radio access network 12 including a base station 14 and a base station controller 16. The radio access network 12 is coupled to a switch fabric 18, which may be a circuit switch network or a packet data network that interconnects the radio access network 12 with a public switched telephone network 22 and other radio or data networks 24. The base station 14 provides wireless communication services to mobile stations 20 operating within a coverage area of the base station 14. Preferably the base station 14 operates in accordance with one or more wireless communication standards, including without limitation a direct sequence code division multiple access (DS-SS) system operating in accordance with the IS-952000 3G standard.

For any end-user, i.e., mobile station 20, the i^{th} chip of an IS-952000 3G spread digital signal S can be modeled as:

$$S_i = (P p_{[p]i} + j D d_i w_i) c_i$$

and consists of a pilot component, $P p_{[p]i}$, and a data-bearing component $[j;], D d_i w_i$, where P and D are the corresponding amplitudes; p is the pilot sequence; d is the interleaved and possibly-repeated coded information sequence; w is the Walsh-code sequence corresponding to the data-bearing component; and c denotes the product of the short and long pseudo-random noise (PN) sequences.

Please delete the four paragraphs starting on Page 5, line 3 and ending on Page 6, line 24 and insert the following:

To estimate r , $h(\theta)$ $\underline{h}^{(0)}$ and $d(\theta)$ $\underline{d}^{(0)}$ denote the despread pilot component and the despread data component, respectively. An estimate $h(1)$ $\underline{h}^{(1)}$ of Ph is obtained by passing

$h(0)$ $\underline{h^{(0)}}$ through a channel estimation filter \underline{f} ; i.e., $\underline{hi(1)} := (\underline{f}^* \underline{H(0)})_i$ $\underline{h_i^{(1)}} := (\underline{f}^* \underline{h^{(0)}})_i$,

where $*$ denotes discrete convolution.

The soft data estimates $\underline{d_i^{(1)}}$ are obtained as follows: First, the $\underline{d_i^{(0)}}$, generated by ~~dispreading~~ despreading the data component are phase compensated using the $\underline{h_i^{(1)}}$,

$$\hat{d}_i := \sum_{a=1}^A \sum_{m=1}^M d_{a,m,i}^{(0)} (h_{a,m,n(i+\delta)}^{(1)})^*$$

where A is the number of receiver antennas; M_a is the number of fingers assigned to resolved rays or multi-path components for antenna a ; and x^* denotes the complex conjugate of x . Second, applying a simplifying assumption that ISI_i , TN_i , MAI_i , and the estimation errors in $\underline{h_i^{(1)}}$ are all uncorrelated and Gaussian Gaussian, then

$$\hat{d}_i = j\mu d_i + [[w]]\underline{\mathcal{E}_i}$$

where $\mu > 0$ and $[[w]]\underline{\mathcal{E}_i}$ denotes a complex-valued, Gaussian random variable whose independent components have mean zero and variance σ^2 . Under this assumption, the conditional expectation of $\underline{d_i}$ given \hat{d}_i is $\underline{E[d_i|\hat{d}_i]} = \tanh(\mu \text{Im}\{\hat{d}_i\}/\sigma^2) \underline{E[d_i|\hat{d}_i]} = \underline{\tanh(\mu \text{Im}\{\hat{d}_i\}/\sigma^2)}$. Third, μ and σ^2 are estimated on a PCG-by-PCG basis as:

$$[[\sigma^2]]\underline{\hat{\sigma}^2} := 1/(i_2 - i_1) \sum_{i=i_1}^{i_2} (\text{Re}\{\hat{d}_i\})^2$$

$$x = 1/(i_2 - i_1) \sum_{i=i_1}^{i_2} (\text{Im}\{\hat{d}_i\})^2$$

$$\hat{\mu} := |x - \hat{\sigma}^2|^{1/2}$$

where $i_1 \leq i \leq i_2$ includes the indices of all coded bits within a specific PCG.

Although the tanh function may be used, in a preferred implementation of the invention, the tanh function is approximated by an applied function t ; hence the soft data estimate of d_i is:

$$d_i^{(1)} := t(\hat{\mu} \text{Im}\{\hat{d}_i\} / [[\sigma^2]] \hat{\sigma}^2)$$

A preferred choice of the applied function t is a piece-wise linear function: for $z \in [0, 2.4]$, this t is obtained by linear interpolation using the $(z, t(z))$ -pairs $(0, 0)$, $(0.625, 0.5721)$, $(1.25, 0.8658)$, and $(2.4, 1)$; for $z > 2.4$, $t(z) := 1$; finally, for $z < 0$, $t(z) := -t(-z)$. The function t is illustrated in FIG. 2.

As will be appreciated from the foregoing discussion, the estimation \hat{d}_i includes an imaginary component and a real component, where the imaginary component is both signal and noise and the real part is only noise. The estimate $[[\sigma^2]] \hat{\sigma}^2$ is an estimate of the average noise power while the estimate x is an average of the signal and noise power. Thus, the estimate μ , the difference of x and $[[\sigma^2]] \hat{\sigma}^2$, is the signal. It will be further appreciated that the estimation \hat{d}_i is obtained at the chip level, and hence, IC is accomplished at the chip level. A re-spreading operation is performed to generate the “cleaned” signal for the final estimation of the coded information sequence d .

Please delete the four paragraphs starting on Page 7, line 4 and ending on Page 8, line 26 with the following:

For partial interference cancellation, the estimate of ~~$r_i^{(1)}$~~ $r_i^{(1)}$ of $s_i h_i$ may be written as:

$$r_i^{(1)} := (\alpha_p p_i + j \alpha_d \eta d_i^{(1)} w_i) c_i h_{n(i)}^{(1)}$$

where α_p and α_d are the partial cancellation coefficients $p_i = 1$ over the first $\frac{3}{4}$ of each PCG (i.e. over the known portion of p) and $p_i = 0$ otherwise; $\eta := D/P$; and $d_i^{(1)}$ is an

estimate of d_i . Since the data bits d_i have a higher rate than the output samples of the filter f , the mapping $n(\cdot)$ is needed to match them appropriately: if the sampling rate of f is ν_1 Hz and the d_i have a rate of ν_2 bits/s, then $n(i) := \lfloor i\nu_1/\nu_2 \rfloor$ (hence, each channel estimate is used for the phase compensation of ν_2/ν_1 bits).

In accordance with a further preferred embodiment of the invention, the partial interference cancellation coefficients α_p and α_d may also be estimated on a PCG-by-PCG basis. For the purpose of this embodiment, a hard estimate $d_i^{(1)}$ is used and is

$$[[\hat{d}]]d_i^{(1)} := \text{sgn}(\text{Im}\{\hat{d}_i\})$$

by recalling that the imaginary part of the \hat{d}_i represents only signal, taking the sign of \hat{d}_i is typically used as an estimate. The estimation error of the signal is $(r_i - r_i^{(1)})$, and taking the partial derivative of the estimation error for each of α_p and α_d , respectively, and solving for α_p and α_d provides the following:

$$\alpha_p = \frac{1}{1 + \rho^2 / |Ph(iT_c)|^2}$$

and

$$\alpha_d = \frac{2\beta - 1}{1 + \rho^2 / |Ph(iT_c)|^2}$$

where $\beta := \mathbf{P}[d_i = d_i^{(1)}]$, i.e., the probability that the data estimate is correct and ρ^2 is the variance of the error in estimating the product $Ph(\cdot)$, and wherein T_c is the duration of the chip.

In accordance with the preferred embodiments of the invention, β is determined in real time. Using the simplified statistical model for \hat{d}_i from above, the conditional probability density function of $d_i^{(1)}$ given d_i is Guassian with mean μd_i and variance σ^2 . Then, assuming that $\mathbf{P}[d_i = 1] = \mathbf{P}[d_i = -1] = 1/2$, it follows that

$$\begin{aligned}
1 - \beta &= P[d_i \neq d_i^{(1)}] \\
&= (1/\sqrt{\pi}) \int_{-\infty}^{-\mu/\sqrt{2\sigma}} e^{-t^2} dt \\
&= \text{erfc}(\mu/\sqrt{2\sigma})/2
\end{aligned}$$

where $\text{erfc}(x) := (2/\sqrt{[[2]]\pi}) \int_x^\infty \exp(-t^2) dt$.

The unknown parameters μ and σ are estimated on a PCG-by-PCG basis as set forth above. Then an estimate of β is:

$$\hat{\beta} := 1 - [[t]]\underline{e}(\hat{\mu}/\sqrt{2\hat{\sigma}})$$

where the approximation $[[t]]\underline{e}(x) \approx \text{erfc}(x)/2$ is introduced for practical implementation. A simple choice for the function $[[t]]\underline{e}$ is a piece-wise linear function; for example, for $x \in [0, 1.8]$, $[[t]]\underline{e}$ is obtained by linear interpolation using the $(x, [[t]]\underline{e}(x))$ -pairs $(0, 0.5)$, $(0.8, 0.1)$, and $(1.8, 0)$; for $x > 1.8$, $[[t]]\underline{e}(x) := 0$, as shown in FIG. 4.